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TITLE: Remote Access to Medical Specialists (RAMS) - Remote  
Patient Care Monitoring Test Bed

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<b>13. ABSTRACT (Maximum 200 Words)</b> The purpose of this program is to demonstrate the applicability of advanced digital medicine techniques to military medicine. It consists of two parts: Critical Care and Chronic Care. The Critical Care portion of this program enables a doctor at Tripler Army Medical Center (TAMC) to view patients and data from patients in the ICU at USNH Guam. This portion of the program was subcontracted to VISICU, a company which has installed somewhat similar systems in the past. The Chronic Care portion is intended to enable a physician to monitor blood glucose and blood pressure taken by patients in their homes from the physician's office. The hardware and software components for the Chronic Care portion are largely complete. The components work in a test setting, but due to difficulties obtaining approvals from IRB and other relevant groups, the hardware and software have not been tested in a doctor/patient setting during this program.				
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## **Introduction**

The purpose of the Remote Access to Medical Specialists (RAMS) – Remote Patient Care Monitoring Test Bed program is to demonstrate the applicability of advanced digital medicine techniques to military medicine; from urgent, combat casualty care to peacetime military readiness and dependent care. The RAMS program focused on the acquisition, transmission, and remote monitoring of real-time patient data on Intensive Care Unit (ICU) patients, and chronically ill patients, either at home or at a remote care site.

## Body

This section describes the research accomplishments associated with each task outlined in the approved Statement of Work.

The RAMS program is divided into two major parts: Intensive Care Unit (ICU) Monitor, also referred to as Critical Care Monitor, and Home Care Monitor (HCM), also referred to as Chronic Care Monitor. Some sections below refer to a single document which covers both of these parts; others cover each of these parts separately. Some of the terminology and concepts described in this section assume familiarity with the System Requirements Document, the System Design Document, or the System Test Plan Document, all of which have been submitted as deliverables for this program.

The task titles and numbers in the list below refer to the corresponding tasks as listed in the Statement of Work. For a description of what was planned for each of these tasks, please consult the Statement of Work itself.

### 1.0 Systems Engineering

#### 1.1 System Requirements

The System Requirements Document has been submitted and approved.

#### 1.2 System Design

The System Design Document has been submitted and approved.

#### 1.3 System Testing Planning

The System Test Plan Document has been submitted and approved.

#### 1.4 Human Use Protocol

The ICU Monitor was installed by VISICU, a subcontractor which developed the system. During the installation, VISICU performed technical tests using only simulated data. Any human use was and will be done by doctors and other appropriate medical personnel at Tripler Army Medical Center (TAMC) and United States Naval Hospital (USNH) Guam, after installation was complete. Since this is an FDA approved system, no Human Use Protocol document or approval is required. An initial Human Use Protocol document for the Home Care Monitor was composed by Trex. This document was delivered to Dr. Vincent, head of Medicine at TAMC, in January 2002. Dr. Vincent and others at TAMC attempted to modify this document in a way that would enable it to be approved by the TAMC Institutional Review Board (IRB), the MRMC IRB, and other appropriate approval boards, but he was unsuccessful in reconciling the differing requirements of the boards. In May 2002 Trex and RAMS project management at TAMC came to the conclusion that there was no longer enough time left in the project to pursue human testing for this part of the program.

### 2.0 Testbed System Development

#### 2.1 Design

Designs of testbed systems for both parts of this program are shown in the System Design Document, which was submitted and approved.

## 2.2 Fabrication

The ICU Monitor system was assembled, configured, and tested by VISICU at VISICU headquarters in Baltimore, MD.

Prototype Home Care Monitor system hardware was designed and assembled by BioSTAR, a subcontractor. Thirty (30) units of this hardware have been procured and assembled, and are currently available for use. Firmware controlling this hardware was written by both Trex and BioSTAR. Three of the four major sections of this firmware are complete, and the fourth section is close to completion. Software for the server which stores measurement data and displays that data to physicians and other medical personnel was written by Trex, with input and approval from Dr. Vincent, Head of Medicine at TAMC. This software is complete.

## 2.3 Integration and Testing

As mentioned above, components of the ICU Monitor system have been assembled, configured, and tested by VISICU at VISICU headquarters. It was then disassembled, shipped to TAMC and USNH Guam, and installed. Prior to installation of the VISICU system, Philips Medical Systems upgraded some medical monitoring hardware and software which had previously been installed by Philips. This upgrading was required so that the existing Philips monitoring equipment could provide data to the VISICU system. Philips also installed their real-time monitoring system at USNH Guam and at TAMC. This is an integral part of the VISICU system.

Home Care Monitor system hardware and software components have been integrated and tested in a laboratory test environment, but due to difficulties getting approval for the Human Use Protocol, final integration and testing has not been completed.

## 3.0 Clinical System Development

### 3.1 Install Equipment

The ICU Monitor system has been installed at USNH Guam and TAMC, as described above.

Components of the Home Care Monitor system have not been installed in a clinical environment, due to difficulties getting approval for the Human Use Protocol.

### 3.2 Data Collection

During installation of the ICU Monitor system, simulated data was used. Because of medical privacy concerns, no data was collected by Trex or VISICU from actual patients. TAMC plans to collect data on an ongoing basis, at least during the first several months of use, in order to determine how beneficial the system is, regarding patient care and cost containment.

The Home Care Monitor system has not been deployed, so no data has been collected.

### 3.3 Data Reduction and Analysis

No work has been done on Data Reduction and Analysis, because no actual patient data has been collected for either of the two major parts of this program.

## 4.0 Management

#### 4.1 Program Management

Overall approaches for each of the two major parts of this program were discussed, evaluated, and chosen. Subcontractors were solicited, evaluated, and selected for each of these parts. Subcontracts were negotiated with VISICU for the ICU Monitor System and with BioSTAR for the Home Care Monitor system development. Trex has monitored and directed the performance of these subcontractors, with frequent phone calls, email, and teleconferences, and occasional face-to-face meetings. During the Period of Performance of this program, Trex has held many teleconferences with the technical and clinical participants of this program, to communicate project progress and to coordinate planning.

#### 4.2 Travel

Trex personnel have traveled as necessary for the performance of other tasks listed in this document.

#### 4.3 Report Preparation

The System Requirements Document has been submitted and approved.

The System Design Document has been submitted and approved.

The System Test Plan Document has been submitted and approved.

Quarterly Progress Review (QPR) meetings have been held, and hard copies of the PowerPoint presentation slides for each QPR have been delivered for each meeting.

The Annual Progress Report has been submitted and approved.

This Final Report has been submitted and is awaiting approval.

The Inventory Report is being prepared and will be submitted shortly.

#### 4.4 Meetings

During much of the Period of Performance of this program, weekly teleconferences have been held to communicate project progress and to coordinate planning. Some of these meetings have been periodically postponed or canceled when all parties involved agreed that the particular meetings were not necessary, or when appropriate personnel were not available at the scheduled meeting time. A Quarterly Progress Review has been held once each quarter, where Trex, occasionally in conjunction with one of its subcontractors, presents a report on progress to date on this program.

## **Key Research Accomplishments**

- No research accomplishments can be reported for the ICU Monitor System, because only simulated patient data was used during the development and deployment of that system. TAMC plans to collect data on an ongoing basis, after the end of the Period of Performance of this contract.
- No research accomplishments can be reported for the HCM System, as that system has not been installed.

## **Reportable Outcomes**

This section is to include manuscripts, abstracts, presentations; patents and licenses applied for and/or issued; degrees obtained that are supported by this award; development of cell lines, tissue, or serum repositories; informatics such as databases and animal models, etc.; funding applied for based on work supported by this award; employment or research opportunities applied for and/or received based on experience/training supported by this award.

With the exception of internal presentations to TAMC and USNH Guam personnel, none of these has been produced during this program.

## **Conclusions**

The process of soliciting, evaluating, and choosing a subcontractor to provide the Intensive Care Unit monitor part of this program has shown that multiple commercially available solutions now exist which can provide partial solutions to the Remote Patient Monitoring problem. While these systems have previously been used to provide monitoring from a distance of tens of miles, this part of this program shows that appropriate modifications to and combinations of such systems can provide monitoring from several thousand miles (TAMC and USNH Guam are approximately 4000 miles from each other). TAMC plans to collect data on an ongoing basis to show how effective this monitoring is.

The development of the Home Care Monitor system has shown that such a system can be built fairly inexpensively, using tried-and-true hardware components and developing a few new software components. The larger problem proved to be obtaining information from the various boards and other groups from which approval was needed to deploy this system.

## References

No references are included in this report.

## **Bibliography**

No publications were produced as a result of this program.

## **Personnel**

This page contains a list of all personnel who received pay from the research effort, not including subcontractors. All personnel listed are (or were) employees of Trex Enterprises. Personnel are listed alphabetically by last name.

Cindy Abreu  
Donna Castle  
Craig Howton  
Jeff Huebotter  
Allen Hunter  
May Hyman  
Nani Marston  
Peter Martin  
John McCoy  
Michael Rodby  
Jennifer Taylor  
Wesley Ueoka

## **Appendices**

No appendices are included in this report.